5.1 Particle Theory of Matter & Classifying Matter

Learning Goals/Success Criteria: *At the end of this lesson, I will be able to:*

- ☐ Describe the Particle Theory of Matter and explain properties of solids/liquids/gases
- ☐ Classify pure substances & mixtures (homogenous vs heterogenous)

Matter is anything that has mass and takes up space (has volume). All matter is made up of particles! Scientist have been observing the particles that make up matter for so long that we now have the Particle Theory. Remember, a "theory" in Science means that many, MANY scientist have gathered evidence that supports this and it is widely accepted conclusion that helps us understand the natural world better.

*The **Particle Theory of Matter** states:*

1. All matter is made up of particles.
2. All particles of one substance are identical.
3. Particles are in constant motion. (Yes! Even when they are frozen!)
4. Temperature affects the speed at which particles move.
5. Particles have forces of attraction between them.
6. There are spaces between particles.

Your mission is to use the demonstrations and activities you see in class today to better understand and use your own evidence to support the Particle Theory of Matter. For each demonstration or activity, record how it supports the Particle Theory of Matter:

Station 1: Food Coloring + Hot Water VS Food Coloring + Cold Water

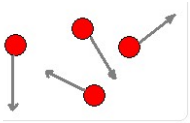
*Instructions: Place **ONE** drop of food colouring in the beaker of **COLD** water and **ONE** drop of food colouring in the beaker of **HOT** water. Do not stir or disturb the beakers as you observe them.*

a. What I observed: *Answers may vary. Food colouring in the hot water diffuses/spreads/moves faster than cold water.*

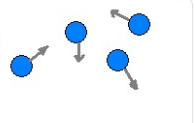
b. Supports Particle Theory of Matter because.... *molecules must be moving in order for the colour to spread*

c. Draw a diagram of the molecules to illustrate your observation.

Hot Water



Cold Water



d. "Pulse points" are those points on the body where you feel your heart beat – wrists, throat, under the ears, on the inner elbow and behind the knees. The veins are closest to the surface of the skin at these points and they are typically warmer than other parts of your body. Why do perfume manufacturers recommend putting perfume on pulse points?

These parts of the body are warmer and the particles of perfume will move faster and travel further because they have more energy.

Station 2: Oil + Water VS Alcohol + Water

Demo A: Water and Oil. Fill one graduated cylinder with 50 ml of oil and another graduated cylinder with 50 ml of water. Pour 50 ml of water into the graduated cylinder with 50 ml of oil.

a. What is the final volume in the cylinder with both water and oil? *~100 mL*

b. What I observed: *Answers may vary. The oil floats on top of the water because it is less dense.*

c. Supports Particle Theory of Matter because....*particles of one substance are identical. All the oil particles stay together and all the water particles stay together. Might think it was spilled/evaporated/compressed but liquids can't be compressed*

Demo B: Water and Alcohol. Fill 50 ml of water in one graduated cylinder and 50 ml of isopropyl alcohol in another graduated cylinder.

a. What do you think the resulting volume will be? *~100 mL*

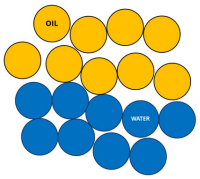
b. Pour the alcohol into the water. What is the actual volume? *Actually less than 100 mL*

c. What I observed: *Answers may vary. The alcohol floats on top of the water because it is less dense. The volume of the two liquids is less than expected. Might think it was spilled/evaporated/compressed but liquids can't be compressed.*

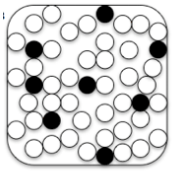
d. Supports Particle Theory of Matter because.... *there are spaces between particles. The alcohol molecules fit between the space of the water molecules so the volume is less than expected.*

e. Draw a diagram of the molecules to illustrate your observation.

Water + Oil



Water + Alcohol



Station 3: Marshmallow and Vacuum Jar

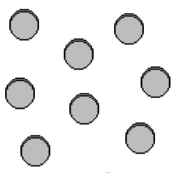
Place one marshmallow under the bell jar and turn on the vacuum pump.

a. What I observed: *Answers may vary. Marshmallow initially expands when the vacuum is on. Then shrinks once the vacuum is removed.*

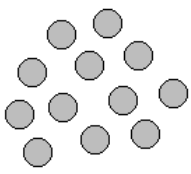
b. Supports Particle Theory of Matter because.... *there are spaces between particles. When the vacuum is on, the space is sucked out of the marshmallow.*

c. Draw a diagram of the molecules to illustrate your observation.

Regular Marshmallow



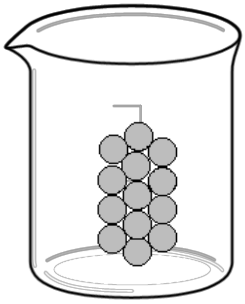
Marshmallow in Vacuum



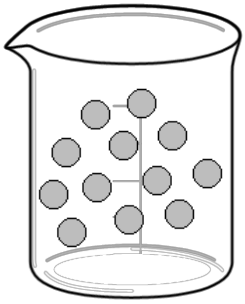
Station 4: States of Matter

Explore what happens to matter as the temperature increases using the following websites:
http://www.harcourtschool.com/activity/states_of_matter/molecules.swf
http://www.harcourtschool.com/activity/science_up_close/501/deploy/interface.swf .

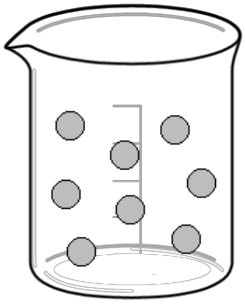
Record how the molecules are arranged and how they are moving for a solid, liquid, and a gas in the diagrams below:



Solid



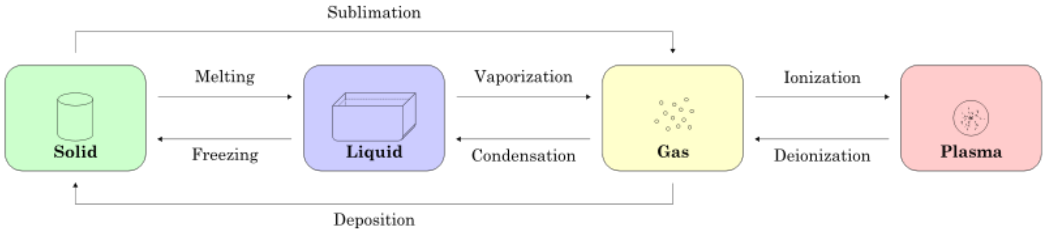
Liquid



Gas

There is a fourth state of matter--Plasma! Draw what your group thinks that the particles are doing in the Plasma phases: *Plasma is a hot ionized gas consisting of negative and positive particles. Particles are even further apart than gases.*

Solids, liquids, and gases are all states or phases of matter. When matter changes from one phase to another, we call this a ***phase change*** and these have specific names. Use arrows to label the diagram below to indicate what the name of each process that helps matter change from one phase to another (do some research if you need!):



Station 5: Review

Go through a review activities and practice test on the following websites:
http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/particle_model/activity/ and
http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/particle_model/revision/2/

Complete a table of the different properties of solids, liquids and gases:

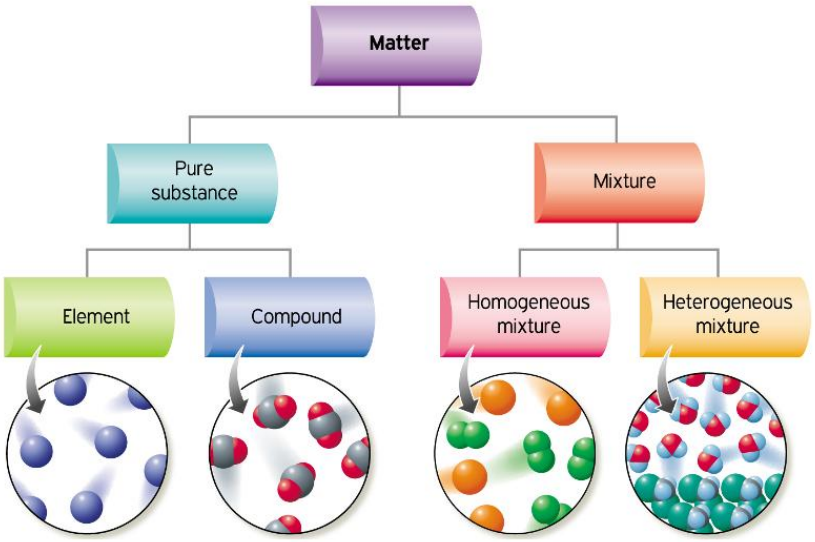
	Solids	Liquids	Gases
Attractions/Bonds	*-held tightly together* *-regular pattern*	*-bonds are strong enough to hold them together but particles can flow* *-random pattern*	*-no bonds* *-far apart* *-arranged in random way*
Compressibility	*- cannot be compressed*	*- cannot be compressed*	*-can be compressed*
Movement	*-cannot flow* *-vibrate in fixed position*	*- can flow* *-move around each other*	*-move very quickly*
Volume and Shape	*-fixed volume & shape*	*-take the shape of their container, fixed volume*	*-take the shape and volume of their container*

Each of the activities/demos illustrated a different point in the Particle Theory of Matter.

The Particle Theory of Matter states:	**Activity/Demo that showed this point:**
1. All matter is made up of particles.	ALL
2. All particles of one substance are identical.	2, 7
3. Particles are in constant motion. (Yes! Even when they are frozen!)	1
4. Temperature affects the speed at which particles move.	1
5. Particles have forces of attraction between them.	2 (all the oil, alcohol & water stay together)
6. There are spaces between particles.	2, 3

Station 6 – Classifying Matter

Matter can be classified according to different characteristics like their physical and chemical properties.



(Note: your text refers to heterogeneous mixtures as mechanical mixtures and homogeneous mixtures as solutions)

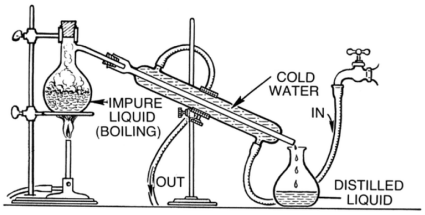
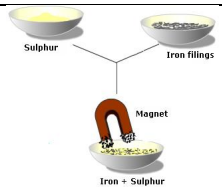
Pure substances are only made up of one type of particle, and can be further categorized into elements or compounds. We will look at elements and compounds in more detail in Chapter 6.

Mixtures are made up of two or more particles and can be further categorized into mechanical (heterogeneous) and solutions (homogenous). A ***mechanical (or heterogenous) mixture*** is a mixture in which the substances are distinguishable from each other. ***Hetero***genous means different and refers to the 2 separate phases of a mechanical mixture. A good example is oil and water.

The substances in ***a solution (or homogenous mixture)*** are not distinguishable from each other because the particles have actually dissolved. ***Homo***genous means same phase and a solution of salt water looks all the same. Solutions can look like pure substance but contain more than one type of particle dissolved in another.

An easy way to tell a solution and mechanical mixture apart is that all liquid and gas solutions are transparent! The solutions remains stable and do not separate. Solutions of solid metals are called ***alloys***. Some common alloys are brass, bronze, solder, and rose gold.

Mixtures can be separated using different methods. *Go through the review activity at:* https://www.bbc.co.uk/education/guides/zgvc4wx/revision and make notes on the following methods.

Method	Example
A filter -separate an insoluble solid from a liquid -insoluble = does not dissolve -soluble = dissolves	
Distillation -separates based on boiling point -the compound with the lower boiling point evaporates first	
A magnet -separates magnetic from non-magnetic compounds	

Station 7 – Classifying Matter

Examine the samples provided and identify them as mechanical mixtures or solutions.

Sample	Observation	Mixture	
		Mechanical	Solution
A	Use a magnet to examine sample A *Some of the sample is attracted to the magnet. Some of it is not.*	✓	
B	Shake sample B and allow to rest on the bench for 2 min. *The sample separates out into different parts as it allows to settle*	✓	
C	Shine the flashlight through sample C *Does not allow light through*	✓	
D	Use the hand lens to examine sample D *Can see different parts of it.*	✓	
E	Add two drops to a small sample of E and mix. *Some of it dissolves. Leaves an insoluble part behind.*	✓	
F	Use the hand lens to examine sample F *Can see different parts of it*	✓	

Extension: Colloids are examples of heterogeneous mixtures that look like homogenous mixtures! Like solutions, they do not separate upon standing and cannot be separated by normal filtration. Like mechanical mixtures, they do not pass the light test. They are classified by the size of their particles. Colloids have particle sizes that consist of clumps of molecules. Some examples of colloids include: aerosols (fog, clouds, smoke, dust), foams (whipped cream), solid foams (marshmallow, Styrofoam), emulsions (milk, mayonnaise, lotion), gels (butter, gelatin), sols (ink, liquid detergent, shampoo) and solid sols (gemstones, some coloured glass & alloys). A sol is a colloid with a solid suspended in either a liquid or another solid.